

PATENT  
514453-3916

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Hornung et al
U.S. Serial No.	:	10/070,242
International Application No.	:	PCT/EP00/08518
International Filing Date	:	August 31, 2000
For	:	<b>FIVE MEMBERED-RING COMPOUNDS AND UTILIZATION THEREOF IN LIQUID CRYSTAL MIXTURES</b>
Confirmation No.	:	2927

745 Fifth Avenue  
New York, New York 10151

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to:  
Assistant Commissioner for Patents, Box PCT  
Washington, D.C. 20231, on October 15, 2002

William F. Lawrence, Registration No. 28,029  
Name of Applicant, Assignee or Registered  
Representative

*Signature*  
October 15, 2002  
Date of Signature

## COMMUNICATION

Assistant Commissioner for Patents  
Box PCT  
Washington, D.C. 20231

Sir:

Enclosed for the Examiner's convenience is a copy of


PATENT  
514453-3916

the International Preliminary Examination Report in  
PCT/EP00/08518

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP  
Attorneys for Applicants

By

  
\_\_\_\_\_  
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## PATENT COOPERATION TREATY

**PCT**  
**NOTIFICATION OF TRANSMITTAL**  
**OF COPIES OF TRANSLATION**  
**OF THE INTERNATIONAL PRELIMINARY**  
**EXAMINATION REPORT**

(PCT Rule 72.2)

From the INTERNATIONAL BUREAU

To:

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Bardehle, Pagenberg, Dost,  
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Frist:

Bsp:

Date of mailing (day/month/year) 25 March 2002 (25.03.02)	
Applicant's or agent's file reference H60582PC /ih	<b>IMPORTANT NOTIFICATION</b>
International application No. PCT/EP00/08518	International filing date (day/month/year) 31 August 2000 (31.08.00)
Applicant CLARIANT INTERNATIONAL LTD et al	

**1. Transmittal of the translation to the applicant.**

The International Bureau transmits herewith a copy of the English translation made by the International Bureau of the international preliminary examination report established by the International Preliminary Examining Authority.

**2. Transmittal of the copy of the translation to the elected Offices.**

The International Bureau notifies the applicant that copies of that translation have been transmitted to the following elected Offices requiring such translation:

JP,KR,US

The following elected Offices, having waived the requirement for such a transmittal at this time, will receive copies of that translation from the International Bureau only upon their request:

EP,DE

**3. Reminder regarding translation into (one of) the official language(s) of the elected Office(s).**

The applicant is reminded that, where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report.

It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned (Rule 74.1). See Volume II of the PCT Applicant's Guide for further details.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer  ALI SOLEIMAN
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

Translation

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

4

Applicant's or agent's file reference H60582PC /ih	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/08518	International filing date (day/month/year) 31 August 2000 (31.08.00)	Priority date (day/month/year) 01 September 1999 (01.09.99)
International Patent Classification (IPC) or national classification and IPC C07D 409/12		
Applicant CLARIANT INTERNATIONAL LTD		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 30 March 2001 (30.03.01)	Date of completion of this report 19 December 2001 (19.12.2001)
Name and mailing address of the IPEA/EP	Authorized officer
Facsimile No.	Telephone No.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP00/08518

## I. Basis of the report

1. This report has been drawn on the basis of (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

- ☐ the international application as originally filed.
- ☒ the description, pages 1-70, as originally filed,  
 pages \_\_\_\_\_, filed with the demand,  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_,  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_.
- ☒ the claims, Nos. 1 (Teil), 11, 12, as originally filed,  
 Nos. \_\_\_\_\_, as amended under Article 19,  
 Nos. \_\_\_\_\_, filed with the demand,  
 Nos. 1 (Teil), filed with the letter of 06 September 2001 (06.09.2001),  
 Nos. 1 (Teil), 2-10, filed with the letter of 27 November 2001 (27.11.2001).
- ☐ the drawings, sheets/fig \_\_\_\_\_, as originally filed,  
 sheets/fig \_\_\_\_\_, filed with the demand,  
 sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_,  
 sheets/fig \_\_\_\_\_, filed with the letter of \_\_\_\_\_.

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheets/fig \_\_\_\_\_

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

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## III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
- ☒ claims Nos. 11, 12

because:

- ☐ the said international application, or the said claims Nos. \_\_\_\_\_  
relate to the following subject matter which does not require an international preliminary examination (*specify*):

- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. \_\_\_\_\_  
are so unclear that no meaningful opinion could be formed (*specify*):

- ☐ the claims, or said claims Nos. \_\_\_\_\_ are so inadequately supported  
by the description that no meaningful opinion could be formed.

- ☒ no international search report has been established for said claims Nos. 11, 12

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP00/08518

## IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☐ all parts.
- ☒ the parts relating to claims Nos. 1-10

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP 00/08518

## Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes III and IV

The objection raised by the search examiner relating to lack of unity of invention is upheld (see the detailed explanation given by the search examiner in the annex to the invitation to pay additional fees), and the division into groups 1 to 6 is adopted in the present report.

The applicant paid an additional search fee for the compounds in group 2. The examination under Chapter II of the PCT therefore addresses groups 1 and 2, which are dealt with separately in this report.



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP 00/08518

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Claims	1-10 (i, ii)	YES
	Claims		NO
Inventive step (IS)	Claims	1-10 (i, ii)	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-10 (i, ii)	YES
	Claims		NO

### 2. Citations and explanations

Group 1: Claims 1-7 (in part), 8, 9 and 10

#### F-Thiophene end group (i)

Liquid crystal compounds with a thiophene end group are already known from the prior art. Without highlighting any particular prior art document, the applicant is referred to the international search report. However, since the fluorine substitution proposed in the present application is not described in or suggested by any of the documents cited, either individually or in combination, this part of the application appears to meet the requirements of PCT Article 33(2) and (3).

Regarding the claims to intermediate products (Claims 8 and 9), attention is drawn to the paper by D.F. ANDRES et al., **Tetrahedron Lett.** 38/6 1049 (1997) (document D1) (see the table on page 1051, compound 2F in conjunction with the details relating to Run 5). The applicant has delimited the scope of protection sought by means of a disclaimer in respect of the alkyl group.

Group 2: Claims 1-7 (in part)

#### Furandiyl end group (ii)

This group of claims relates to liquid crystal compounds with a furan-2,5-diyl or furan-2,4-diyl end group. The following documents are relevant to such compounds:

DE-A-44 46 836 (document D2) - see Example 5, and also the paragraph from the bottom of page 2 to the top of page 3, which refers to the relatively high switching speed.

J.W. BROWN et al., Mol. Cryst. Liq. Cryst. 173, 121 (1989) (document D3) - see compounds (III) and (IV) on page 122 and the compound shown in Figure 5; also the details given on page 132.

M.A. OSMAN et al., Mol. Cryst. Liq. Cryst. 82, 339 (1983) (document D4) - see compound 6 in reaction scheme 2 together with the definition of R in Table 2.

See also JP-A-63 060 981 (document D5) and Takenaka et al., Mol. Cryst. Liq. Cryst. 131, 257 (1985) (document D6).

In the light of this prior art, the applicant has specified the following points in Claim 1:

- The definition of  $R^2$  has been restricted by deleting "hydrogen" as a possible meaning, thus allowing only alkyl-substituted furan end groups for this type of compound.
- At the end of the definition of  $M^1$  and  $M^2$  a stipulation has been added whereby when T is furan-2,5-diyl or furan-2,4-diyl,  $M^1$  is a single bond.

The claimed subject matter is thus also delimited against the relevant prior art. The applicant has also put forward a persuasive argument concerning inventive step, to the effect that the properties of the claimed compounds (ferroelectric liquid crystal mixtures for active matrix elements) are not obvious from the prior art. The significant point regarding the structure is the combination of an alkyl-substituted furan end group and directly joined  $A^1/A^3$  cyclic compounds (where  $a = 1$ ) as the base element.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP 00/08518

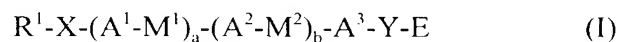
## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

Upon entry into the national or regional phase, documents D1 to D4 should be cited in the description (PCT Rule 5.1(a)(ii)) and the description should also be amended.

"as enclosed to IPER"Patent claims

- 5 1. A five-membered ring compound of the formula (I),



where the symbols and indices have the following meanings:

10

**E** is a radical T-Z-R<sup>2</sup> containing a five-membered ring, where:

15

- (i) **T** is undirected and is  
4-fluorothiophene-2,5-diyl, 3-fluorothiophene-2,5-diyl,  
3-fluorothiophene-2,4-diyl or 5-fluorothiophene-2,4-diyl  
**Z** is a single bond or -O-  
**R**<sup>2</sup> is hydrogen or a straight-chain or branched alkyl radical (with or  
without asymmetric carbon atoms) having 1 to 20 carbon atoms,  
where one nonterminal CH<sub>2</sub> group may be replaced by -O- or  
-OC(=O)- or -C(=O)O- and/or one or more H atoms may be  
replaced by F, with the provisos that  
b) the -CH<sub>2</sub>- group nearest to the thiophene cannot be replaced by  
-O- when Z is -O-  
b) R<sup>2</sup> can only be hydrogen when Z is a single bond,

25

- (ii) **T** is furan-2,5-diyl or furan-2,4-diyl  
**Z** is a single bond or -O-  
**R**<sup>2</sup> is a straight-chain or branched alkyl radical (with or without  
asymmetric carbon atoms) having 1 to 20 carbon atoms, where

30

one nonterminal CH<sub>2</sub> group nonadjacent to furan may be replaced by -O- or -OC(=O)- or -C(=O)O- and/or one or more H atoms may be replaced by F,

5

- (iii) **T** is undirected and is isoxazole-3,5-diyl  
**Z** is a single bond or -O-

10

**R<sup>2</sup>** is hydrogen or a straight-chain or branched alkyl radical (with or without asymmetric carbon atoms) having 1 to 20 carbon atoms, where one nonterminal CH<sub>2</sub> group may be replaced by -O- or -OC(=O)- or -C(=O)O- and/or one or more H atoms may be replaced by F, with the provisos that

15

- a) the -CH<sub>2</sub>- group nearest to the isoxazole cannot be replaced by -O- when Z is -O-  
b) R<sup>2</sup> can only be hydrogen when Z is a single bond,

20

- (iv) **T** is undirected and is thiazole-2,5-diyl or thiazole-2,4-diyl  
**Z** is a single bond  
**R<sup>2</sup>** is hydrogen or a straight-chain or branched alkyl radical (with or without asymmetric carbon atoms) having 1 to 20 carbon atoms, where one nonterminal CH<sub>2</sub> group may be replaced by -O- or -OC(=O)- or -C(=O)O- and/or one or more H atoms may be replaced by F,

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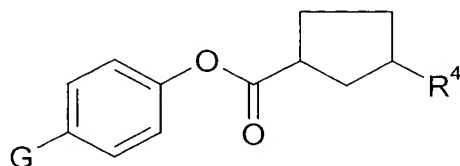
- (v) **T** is cyclopentane-1,3-diyl  
**Z** is a single bond or -O-  
**R<sup>2</sup>** is hydrogen or a straight-chain or branched alkyl radical (with or without asymmetric carbon atoms) having 1 to 20 carbon atoms, where one nonterminal CH<sub>2</sub> group may be replaced by -O- or -OC(=O)- or -C(=O)O- and/or one or more H atoms may be replaced by F, with the provisos that

a) the  $-\text{CH}_2-$  group nearest to the cyclopentane cannot be replaced by  $-\text{O}-$  when  $Z$  is  $-\text{O}-$

b)  $\text{R}^2$  can only be hydrogen when  $Z$  is a single bond.

5

with the exception of compounds of the formula (II)



(II)

10 in which

$\text{R}^4$  is as defined for  $\text{R}^2$

$\text{G}$  is trans-4-propyl-cyclohexyl or trans-4-butyl-cyclohexyl or an alkyl group of 1 to 15 carbon atoms, in which, in addition, one or more nonadjacent  $\text{CH}_2$  groups may be replaced by  $-\text{O}-$ ,  $-\text{CO}-$ ,  $-\text{OCO}-$ ,  $-\text{O}-\text{CO}-\text{O}-$ ,  $-\text{CHhalogen}-$ ,  $-\text{CHCN}-$  and/or  $-\text{CH}=\text{CH}-$  or is F, CN.

15

(vi)  $\text{T}$  is cyclopentane-1,3-diyl, in which one  $-\text{CH}_2\text{CH}_2-$  or  $-\text{CH}_2\text{CH}-$  group is replaced by a  $-\text{CH}=\text{CH}-$  or  $\text{CH}=\text{C}-$  group respectively

$\text{Z}$  is a single bond

20

$\text{R}^2$  is hydrogen or a straight-chain or branched alkyl radical (with or without asymmetric carbon atoms) having 1 to 20 carbon atoms, where one nonterminal  $\text{CH}_2$  group may be replaced by  $-\text{O}-$  or  $-\text{OC}(=\text{O})-$  or  $-\text{C}(=\text{O})\text{O}-$  and/or one or more H atoms may be replaced by F, with the proviso that the  $-\text{CH}_2-$  group nearest to the cyclopentene cannot be replaced and where

25

$\text{Y}$  cannot be  $-\text{CH}_2-\text{CH}_2-$ .

**R<sup>1</sup>** is hydrogen or a straight-chain or branched C<sub>1-20</sub>-alkyl or C<sub>2-20</sub>-alkenyl radical (with or without asymmetric carbon atoms), where

- a) one or two nonterminal CH<sub>2</sub> groups may be replaced, independently of one another, by -O- or -C(=O)-, with the proviso that two adjacent CH<sub>2</sub> groups cannot be replaced in the same way, and/or
- b) one CH<sub>2</sub> group may be replaced by -C≡C-, and/or
- c) one CH<sub>2</sub> group may be replaced by -Si(CH<sub>3</sub>)<sub>2</sub>-, cyclopropane-1,2-diyl, cyclobutane-1,3-diyl, cyclopentane-1,4-diyl, bicyclo[1.1.1]pentane-1,3-diyl or cyclohexane-1,4-diyl, and/or
- d) one or more H atoms may be replaced by F and/or CN,
- e) in the case of a branched alkyl radical containing asymmetric carbon atoms, the asymmetric carbon atoms have -CH<sub>3</sub>, -OCH<sub>3</sub>, -CF<sub>3</sub>, F, CN and/or Cl as substituents or are incorporated into a 3- to 7-membered ring, in which, in addition, one or two non-adjacent CH<sub>2</sub> groups may be replaced by -O- and one CH<sub>2</sub> group non-adjacent to these groups may be replaced by -OC(=O)-;

**X** is a single bond, -O-, OC(=O)-, -C(=O)O- or -OC(=O)O-  
**Y** is -OC(=O)-, -OCH<sub>2</sub>-, -CH<sub>2</sub>CH<sub>2</sub>-

**A<sup>1</sup>, A<sup>2</sup>, A<sup>3</sup>** are each, independently of one another, phenylene-1,4-diyl, unsubstituted or monosubstituted or disubstituted by CN or F, phenylene-1,3-diyl, unsubstituted or monosubstituted or disubstituted by CN or F, cyclohexane-1,4-diyl, in which one or two H atoms may be replaced by CN and/or CH<sub>3</sub> and/or F, 1-cyclohexene-1,4-diyl, in which one H atom may be replaced by F, 1-alkyl-1-silacyclohexane-1,4-diyl, pyridine-2,5-diyl, unsubstituted or monosubstituted by F, pyrimidine-2,5-diyl, unsubstituted or monosubstituted by F, cyclopentane-2,5-diyl or thiophene-2,5-diyl;

$M^1$ ,  $M^2$  are undirected and are each, independently of one another,

-OC(=O)-, -OCH<sub>2</sub>-, -CH<sub>2</sub>CH<sub>2</sub>-, -OC(=O)CH<sub>2</sub>CH<sub>2</sub>-, -OCH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>-,

-C≡C-, -CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>- or a single bond;

5 when T is furan-2,5-diyl or furan-2,4-diyl,  $M^1$  is a single bond;

**a**, **b** are each, independently of one another, 0 or 1.

2. A liquid-crystal mixture comprising at least one compound of the formula (I) as  
10 claimed in claim 1.

3. A liquid-crystal mixture as claimed in claim 2, which comprises from 0.01 to 80% by weight of one or more compounds of the formula (I).

15 4. A liquid-crystal mixture as claimed in claim 2 or 3, which is ferroelectric (chiral smectic).

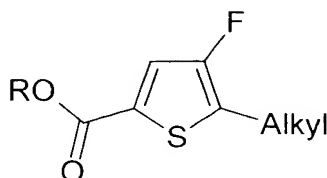
5. A liquid-crystal mixture as claimed in claim 2 or 3, which is nematic.

20 6. A ferroelectric switching and/or display device, which contains a ferroelectric liquid-crystal mixture as claimed in claim 4.

7. A ferroelectric switching and/or display device as claimed in claim 6, which contains active matrix elements and wherein the liquid-crystal layer forms a  
25 monostable monodomain.



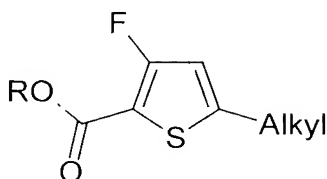
8. A 5-alkyl-4-fluoro-thiophene-2-carboxylic acid of the formula (II)



(II)

in which alkyl is a straight-chain or branched alkyl radical of 2 to 16 carbon atoms with the exception of tert.-butyl, and R is hydrogen, alkali metal, alkaline earth metal (1/2), a straight-chain or branched alkyl radical of 1 to 16 atoms with the exception of methyl and tert-butyl, or a corresponding acid halide.

9. A 5-alkyl-3-fluoro-thiophene-2-carboxylic acid of the formula (III)



(III)

in which alkyl is a straight-chain or branched alkyl radical of 2 to 16 carbon atoms and R is hydrogen, alkali metal, alkaline earth metal (1/2), a straight-chain or branched alkyl radical of 1 to 16 atoms or a corresponding acid halide.

10. The use of compounds of the general formulae (II) and (III) as claimed in claims 8 and 9 for preparing liquid crystals.

11. A fluorinated five-membered ring compound as claimed in claim 1, wherein, in the cyclopentene derivatives (vi), **T** is 1-cyclopentene-1,3-diyl, 1-cyclopentene-1,4-diyl or 3-cyclopentene-1,3-diyl.

5

12. A fluorinated five-membered ring compound as claimed in claim 11, wherein, in the cyclopentene derivatives (vi), the moiety **-Y-T-** is 1-cyclopentene-1-carboxyloxy-3-yl, 1-cyclopentene-1-carboxyloxy-4-yl or 3-cyclopentene-1-carboxyloxy-3-yl.

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Translation

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

4

Applicant's or agent's file reference H60582PC /ih	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
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Date of submission of the demand 30 March 2001 (30.03.01)	Date of completion of this report 19 December 2001 (19.12.2001)
Name and mailing address of the IPEA/EP	Authorized officer
Facsimile No.	Telephone No.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP00/08518

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4. Additional observations, if necessary:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

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## III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application.
- ☒ claims Nos. 11, 12

because:

- ☐ the said international application, or the said claims Nos. \_\_\_\_\_  
relate to the following subject matter which does not require an international preliminary examination (*specify*):

- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. \_\_\_\_\_  
are so unclear that no meaningful opinion could be formed (*specify*):

- ☐ the claims, or said claims Nos. \_\_\_\_\_ are so inadequately supported  
by the description that no meaningful opinion could be formed.

- ☒ no international search report has been established for said claims Nos. 11, 12

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## IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☐ all parts.
- ☒ the parts relating to claims Nos. 1-10

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**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes III and IV

The objection raised by the search examiner relating to lack of unity of invention is upheld (see the detailed explanation given by the search examiner in the annex to the invitation to pay additional fees), and the division into groups 1 to 6 is adopted in the present report.

The applicant paid an additional search fee for the compounds in group 2. The examination under Chapter II of the PCT therefore addresses groups 1 and 2, which are dealt with separately in this report.

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## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims	1-10 (i, ii)	YES
	Claims		NO
Inventive step (IS)	Claims	1-10 (i, ii)	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-10 (i, ii)	YES
	Claims		NO

## 2. Citations and explanations

Group 1: Claims 1-7 (in part), 8, 9 and 10

**F-Thiophene end group (i)**

Liquid crystal compounds with a thiophene end group are already known from the prior art. Without highlighting any particular prior art document, the applicant is referred to the international search report. However, since the fluorine substitution proposed in the present application is not described in or suggested by any of the documents cited, either individually or in combination, this part of the application appears to meet the requirements of PCT Article 33(2) and (3).

Regarding the claims to intermediate products (Claims 8 and 9), attention is drawn to the paper by **D.F. ANDRES et al.**, **Tetrahedron Lett.** 38/6 1049 (1997) (document D1) (see the table on page 1051, compound 2F in conjunction with the details relating to Run 5). The applicant has delimited the scope of protection sought by means of a disclaimer in respect of the alkyl group.

Group 2: Claims 1-7 (in part)

**Furandiyl end group (ii)**

This group of claims relates to liquid crystal compounds with a furan-2,5-diyl or furan-2,4-diyl end group. The following documents are relevant to such compounds:



DE-A-44 46 836 (document D2) - see Example 5, and also the paragraph from the bottom of page 2 to the top of page 3, which refers to the relatively high switching speed.

J.W. BROWN et al., Mol. Cryst. Liq. Cryst. 173, 121 (1989) (document D3) - see compounds (III) and (IV) on page 122 and the compound shown in Figure 5; also the details given on page 132.

M.A. OSMAN et al., Mol. Cryst. Liq. Cryst. 82, 339 (1983) (document D4) - see compound 6 in reaction scheme 2 together with the definition of R in Table 2.

See also JP-A-63 060 981 (document D5) and Takenaka et al., Mol. Cryst. Liq. Cryst. 131, 257 (1985) (document D6).

In the light of this prior art, the applicant has specified the following points in Claim 1:

- The definition of R has been restricted by deleting "hydrogen" as a possible meaning, thus allowing only alkyl-substituted furan end groups for this type of compound.
- At the end of the definition of M<sup>1</sup> and M<sup>2</sup> a stipulation has been added whereby when T is furan-2,5-diyl or furan-2,4-diyl, M<sup>1</sup> is a single bond.

The claimed subject matter is thus also delimited against the relevant prior art. The applicant has also put forward a persuasive argument concerning inventive step, to the effect that the properties of the claimed compounds (ferroelectric liquid crystal mixtures for active matrix elements) are not obvious from the prior art. The significant point regarding the structure is the combination of an alkyl-substituted furan end group and directly joined A<sup>1</sup>/A<sup>2</sup> cyclic compounds (where a = 1) as the base element.

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VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

Upon entry into the national or regional phase, documents D1 to D4 should be cited in the description (PCT Rule 5.1(a)(ii)) and the description should also be amended.